nationalgrid

Electricity Transmission

Delivering our environmental future: annual statement

March 2016

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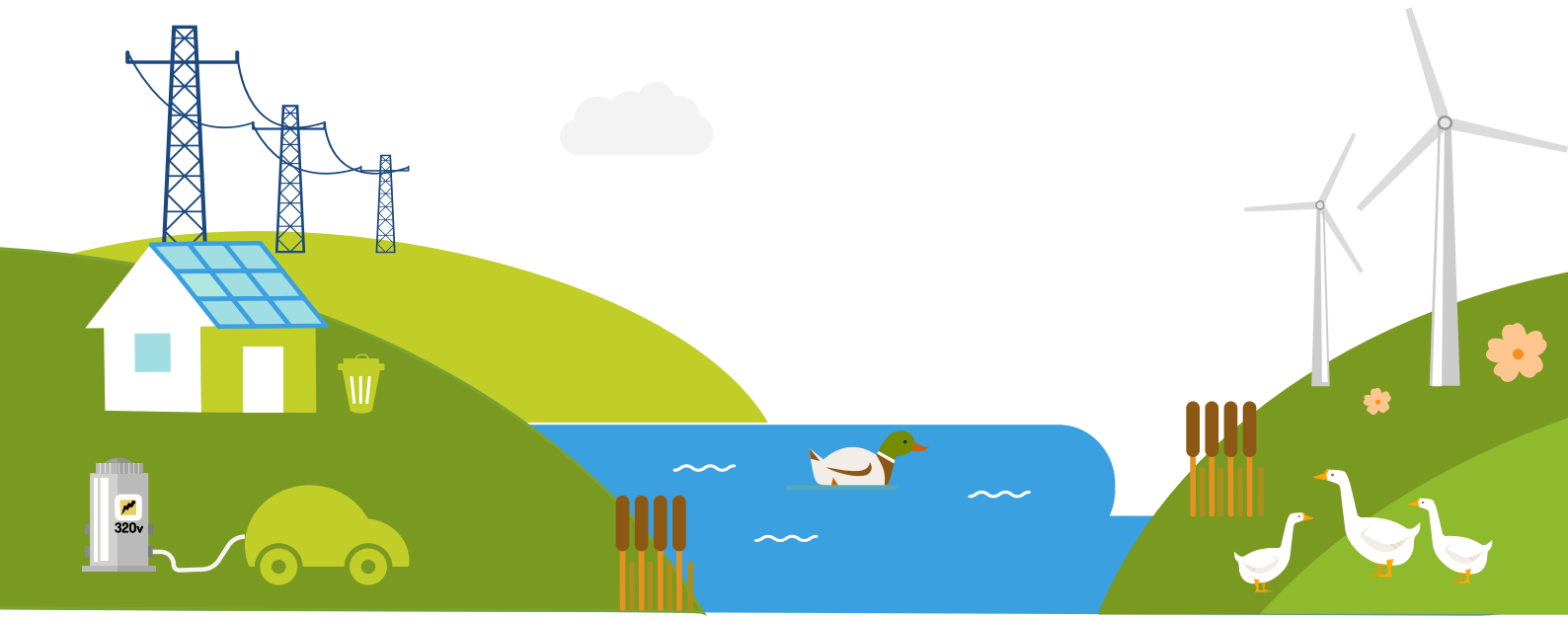


Foreword
John Pettigrew

This year I'm incredibly proud to report that our new Carbon Interface Tool won the Sustainability Leaders Award for Carbon Management

At National Grid we're passionate about delivering a low-carbon network as part of important efforts to tackle climate change. That's why we aim to maintain high standards in environmental management as we increase our use of low-carbon technology. It's also why we're working hard to deliver safe and reliable networks that provide value for money for consumers. This 2016 statement summarises what we are doing in 2016 and beyond in order to achieve these commitments.

We have a crucial responsibility to help make the transition to a low-carbon economy happen. We are fully committed to connecting as many new sources of low-carbon generation as possible, and we'll do this in a sustainable way that meets the government's security of supply objectives.

This year I'm incredibly proud to report that our new Carbon Interface Tool won the Sustainability Leaders Award for Carbon Management. As well as sharing the tool with our suppliers, we're now offering demonstrations to our stakeholders so that we can all share good practice and increase carbon knowledge both within and outside the industry. Our stakeholders continue to help us prioritise and lead on these changes.

Additionally, in 2015/16 we introduced several innovation projects and initiatives that provided environmental benefits for our customers and stakeholders while also helping our carbon-management work. For example, we're currently piloting how we can harvest and use heat given off by substation transformers to heat neighbouring buildings. We'll use the learnings from these projects to help us make more informed decisions and develop more effective approaches in the future.

Our stakeholders have an important role to play in helping us deliver a low-carbon energy system and by working together, we can find innovative solutions. That's why we're committed to working with our stakeholders throughout 2016 and beyond.

We'd love to hear your views.

John Pettigrew
Executive Director, UK

WHAT DO YOU THINK?

On page 23 we explain how you can give us feedback on this document.

Planning for a low-carbon future

Within National Grid we have broad experience and are viewed as a thought leader for sustainability and the transition to low carbon. As one of our group of companies, National Grid Electricity Transmission (NGET) taps into this resource and contributes to it.

Below we outline how we plan for a low-carbon future.

National Grid Electricity Transmission

Planning for a low-carbon future (**p4-5**)
Connecting low-carbon generation (**p6-7**)
How we'll operate the system in the future (**p8-9**)

Facilitating the energy market

We want to help the energy market achieve its full potential. As part of this, we'll keep building and operating reliable networks.

The electricity market is going through a time of significant and rapid change, caused mainly by the transition to low-carbon energy sources and producing energy closer to where it's consumed. We recognise the need for improved planning in order to manage the transition successfully.

Our planning process centres on a robust and evolving stakeholder engagement framework. We continuously improve and refocus it because the future of our business is inextricably linked to the energy market and the decisions made by those who operate within it.

Our Future Energy Scenarios (FES) process lies at the heart of the framework, supported by our strong analytical capabilities. By creating credible and plausible scenarios for the future of energy in Great Britain, we're helping the energy industry to plan how to achieve the low-carbon transition. Many stakeholders, including developers of storage, renewable and nuclear generation projects and associated supply chain companies, benefit directly from using these scenarios.

Within NGET, the FES plays a vital role in almost all our planning activities:

- our network planning and investment decision processes, like the Electricity Ten Year Statement (ETYS) and the Network Options Assessment (NOA) – in 2015 we extended NOA to cover the whole of Great Britain
- assessing future challenges and devising solutions for operating the network, including the System Operability Framework (SOF) and our Power Responsive campaign, which we launched in 2015 to increase participation of electricity demand in the market – a critical enabler of a low-carbon future
- informing our assessment of short-term security of supply – for example, our winter and summer Outlook reports
- helping industry forums to plan the commercial framework changes needed to achieve a smooth low-carbon transition – a good example is the Connection and Use of System Code (CUSC) issues standing group, which we chair.

The FES evolves year on year, as underlying economic and technological conditions change. We take on board stakeholder feedback and make sure we incorporate these insights and improvements in our approach.

Before publishing the 2016 FES we've made many improvements, including the following:

- we've introduced new ways to communicate with our stakeholders, including webinars, interactive workshops and an enhanced online presence. As a result, the number of organisations that got involved shot up from 233 to 362
- during our FES 2015 consultation 45 per cent of stakeholders said they wanted us to be clearer about how the FES assumptions and inputs are created and used. So in the 2016 FES we'll introduce a more structured approach to grouping our inputs and assumptions
- our stakeholders said they wanted the FES to include more insight. So this year's FES will incorporate improved signposting and more statements about what developments would be required in order to make the different scenarios happen. A new 'Spotlights' feature will allow us to explore important topics in more detail and to inform stakeholders about developments that aren't yet mature enough to be included as an input into our analysis.

The way we do business

National Grid's highly experienced Safety, Environment and Health Committee reviews the company's strategies, policies, initiatives, risk exposure, targets and performance.

Our sustainability strategy is called 'Our Contribution' (p10-11). It sets out our ambition to transform the way we do business so that we reduce our environmental impact, add value and help the transition towards a low-carbon energy system. The Safety, Sustainability and Resilience function is responsible for developing the strategy, which is reviewed and endorsed by the Safety, Environment and Health Committee. We've grouped the targets and commitments within the strategy into three themes: climate positive (p14-15), positive about resources (p16-17) and enhancing ecosystems (p18-19).

Innovation

We've been putting a lot of effort into developing a culture of innovation across National Grid (p20-22). It's all part of our plan to help make the low-carbon transition happen – in the most cost-effective way in the long term – for the benefit of all our stakeholders.

That effort is now starting to bear fruit: we have more than 100 innovation projects running within NGET, covering our functions as transmission network asset owner in England and Wales and as system operator across Great Britain.

The electricity market is going through a time of significant and rapid change, caused mainly by the transition to low-carbon energy sources and producing energy closer to where it's consumed.

Connecting
low-carbon generation

2015/16 was a transformational year for National Grid Electricity Transmission. We embedded new ways of working to help us connect more than 7.7GW of renewable distributed generation to the Distribution Network Operator (DNO) networks.

We led these innovative approaches by working closely with all DNOs, the Department of Energy & Climate Change (DECC) and Ofgem, which is the government regulator for gas and electricity markets in Great Britain. This was a step change in the level of understanding and working with the distribution network owners to develop a whole-system approach to planning and operating the electricity networks.

In 2014, the levels of distributed generation weren't a problem and we were able to complete the new connections without any operational issues arising on the transmission network. But 2015 was a different story altogether, with a sharp increase in applications to connect to the DNOs distribution networks.

If we'd stuck to National Grid's business-as-usual processes and policies, much of this distributed generation connection work would have been delayed while the distribution or transmission solutions were being developed and installed.

This was not acceptable to us, so we led the collaboration with the DNOs, DECC and Ofgem – individually and collectively – at industry workshops to develop new solutions and ways of working. For example, working with the DNOs, we developed a new approach that allowed them to 'bulk together' applications for distributed generation. This resulted in more than 4GW of new connection requests being submitted in four months.

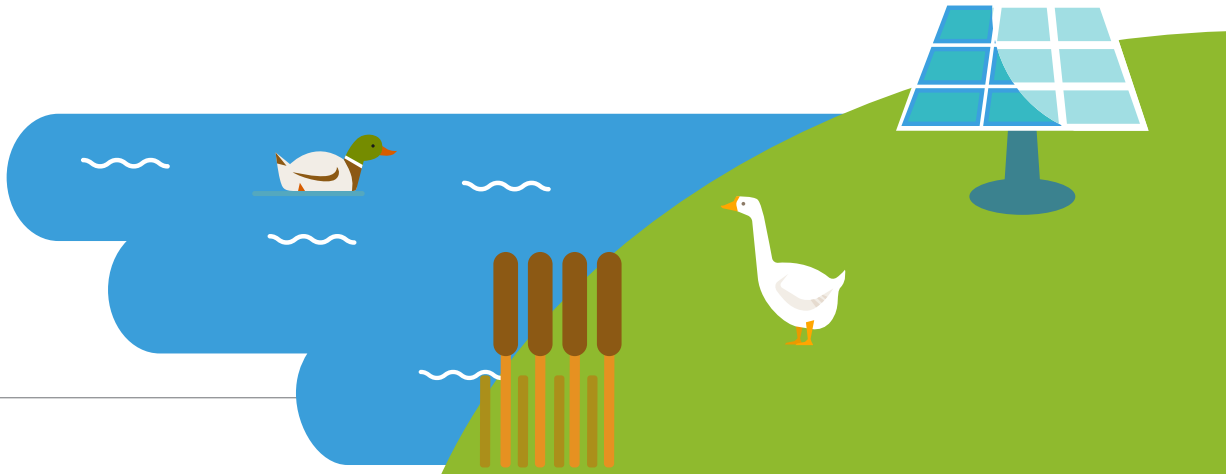
Some of these solutions are 'quick wins' to make sure the next 12 to 24 months of connections go ahead according to plan. We developed them by working closely with National Grid technical experts and the DNOs. We also trialled some potential solutions in local areas on the live network, to make sure that the expected benefit could be achieved in real time. These trials were successful and are now part of the everyday operation of the whole-system network.

Many other solutions are still being developed and will create a long-term sustainable approach to both whole-system planning and managing distributed generation.

The short-term solutions have achieved the following:

- restricted access for distributed generation
- all new distributed generation operates within certain technical parameters that support its connection
- DNOs operate their network at a lower voltage
- we constrain transmission connected generation to allow for distributed generation output under certain conditions
- we assessed how the output from different renewable technologies varies with the weather conditions and calculated reasonable likely output ratios across a geographic area.

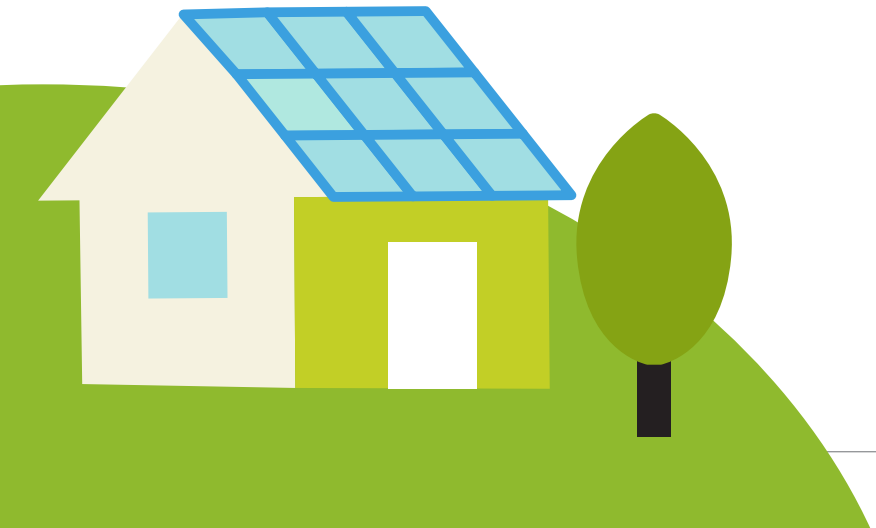
The outcome of this project is impressive: we've been able to make a further 7.7GW of connection



agreements with the distributed generation community. This represents enough energy to supply around 1.8 million homes and displace 2.6 million tonnes of CO_2. Without this project we would only have achieved up to 2GW of connection agreements. The DNOs, DECC, Ofgem and National Grid continue to work together with the Energy Network Association to develop longer-term solutions and a regulatory and commercial framework that's fit for purpose.

In the longer term, National Grid's Future Energy Scenarios show a continuing increase in distributed generation throughout the next 20 years and beyond. It will rise from 23GW of all distributed generation installed at the end of 2015/16 to around 70GW under the Gone Green scenario in 2040. This is a clear signal: we need to develop longer-term processes and policies to make sure we can keep facilitating the connection of distributed generation. These policies and processes need to consider the whole system so that solutions and investments can be identified, funded and implemented.

We've made a further 7.7GW of connection agreements with the distributed generation community. This represents enough energy to supply around 1.8 million homes



How we'll operate the system in the **future**

We face challenges and opportunities in operating our power networks. These include changes in the generation mix and demand side, as well as new technologies coming to the system.

National Grid developed the System Operability Framework (SOF) in 2014. In this annual process we can study the Future Energy Scenarios (FES) in detail to see how changes in the energy landscape affect system operability. We received an overwhelming response from our stakeholders to the first SOF. They encouraged us to improve the SOF process and our capabilities to enhance the framework.

This year, improvements to SOF include a transparent and comprehensive stakeholder engagement programme for the entire process. This significantly increased the participation and reach of our engagement: we had 1,106 SOF downloads in the first 30 days – that's an increase of more than 400 per cent on the previous year.

In selecting topics for this year, we considered factors like last year's analysis, responses to the 2014 consultation, FES 2015 developments and what stakeholders told us at our pre-assessment workshop.

We've grouped the technical topics studied this year into different categories, mainly because of the change in generation mix and demand, and the new technologies on the system. We need to explore and develop solutions to all of these topics to allow a safe and secure transition to a low-carbon network. Shown below is a summary of our findings.

System inertia

All our scenarios show declining system inertia because of the lack of synchronous (traditional) thermal power stations and the high volume of converter-connected generation technologies such as solar PV, wind and imports across our high-voltage direct-current (HVDC) interconnectors. That's why we're asking the embedded generation to adjust some of their protection settings – so that if system frequency falls we don't lose even more generation and make things worse.

We need new services to help manage the system frequency, because the frequency response requirement will increase by 30 to 40 per cent in the next five years. To help stop the initial frequency fall, we ran a fast frequency response (EFR) procurement process with the industry to get expressions of interest for up to 200MW of EFR. We received applications for more than 1.3 MW of projects and we're now working with applicants to understand their technology and technical characteristics.

This trend continues and the response requirement between 2025 and 2030 will be three to four times higher than the current level, with limited access to the services that are available now. Our enhanced frequency control capability project (funded as part of the 2014 Network Innovation Competition) and our collaborative Power Responsive campaign will make it easier for the energy sector to understand our need for new services to operate the network because they explain the technical and commercial developments that are needed.

System strength and resilience

With the move to a low-carbon network, the system strength is weakening, showing that natural support to the grid is reduced. Although low-carbon technologies have some capabilities (such as dynamic voltage control) to provide the necessary support, we must make more use of these capabilities. For instance, we need better access to demand-side services from energy storage, embedded generation and industrial and commercial demand. This is particularly important in the context of voltage containment, which has been a challenging issue for years; there will be significant increase in demand for additional reactive compensation over the next 20 years.

This year we've entered into contracts to provide these services with low-carbon generation projects. We

The frequency response requirement will increase by

30-40%

in the next five years

have collaborated with the generator owners to fully understand what the system operator needs and how their generation can meet those requirements.

We're also looking at the whole system to make best use of our own and the DNOs' existing resources and controls to manage network voltages.

Embedded generation

We've focused on the impacts of the large amounts of low-carbon generation connected to the distribution network. We need new capabilities to keep the transmission system stable – National Grid and the Scottish Transmission Operators and DNOs must work more closely together to address these issues because some of the solutions will involve co-ordinating services between transmission and distribution networks.

We're working closely with a wide range of stakeholders (DNOs, TOs, developers, Ofgem and DECC) to consider the whole-system impacts of embedded generation. Together we will find better ways to run the whole system, economically and efficiently.

Our **Contribution**

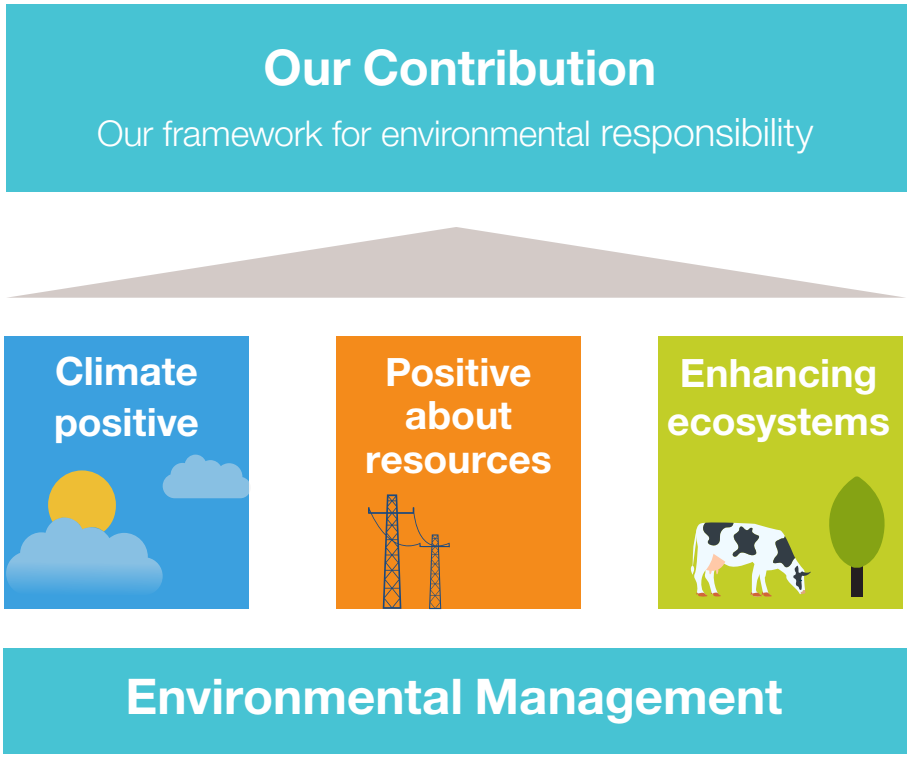
National Grid's Sustainability Strategy – we call it 'Our Contribution' – sets out our ambition. We want to transform the way we do business so that we reduce our environmental impact, add value and help make the transition to a low-carbon energy system.

By doing the right thing we aim to deliver lasting value to customers, investors, employees and society.

Our Contribution outlines our sustainability commitments and targets. We've grouped them into three environmental responsibility themes: climate positive, positive about resources and enhancing ecosystems. These themes sit upon the strong foundation of our Environmental Management System (EMS).

Our sustainability strategy provides a lens that we can use to improve our business models, guide our decisions and define our main sustainable priorities. We want each area of our business to work towards meeting our sustainability objectives. That's why we're using clear and succinct messages to communicate our strategy and developing new tools to help us monitor our environmental performance and encourage innovation.

We've set ourselves ambitious sustainability targets. For example, we aim to reduce our greenhouse gas emissions by 45 per cent by 2020 and to implement sustainable action plans at 50 of our sites by 2020. Since we launched Our Contribution in 2012, we've made good progress towards reaching or exceeding these targets. Following the global climate agreement at the United Nations Conference of the Parties on Climate Change (COP21) in December 2015, we're also now making sure that our climate change targets are in line with the agreed 2°c temperature rise limit.



In 2016 we'll focus on refreshing Our Contribution alongside National Grid's responsibility strategy so that:

- people across the business fully understand the policy
- it presents our aims in an engaging way to employees and external stakeholders
- it includes specific performance measures to drive future improvement and investment.

To achieve this, we plan to meet and talk with many stakeholders, so that we can take on board their feedback about our communications and our target-setting. We're planning to go live with an updated version of Our Contribution later this year.

Our Sustainability Steering Committee meets quarterly and provides direction, guidance and challenge for embedding sustainability. In 2015 we launched an Electricity Transmission Operator (ETO) Sustainable Substation Working Group – it includes people from different areas of our business and encourages them to work together on the design and management of our Electricity Transmission assets. We're trialling an

approach that incorporates non-financial indicators into decision-making processes within our ETO business.

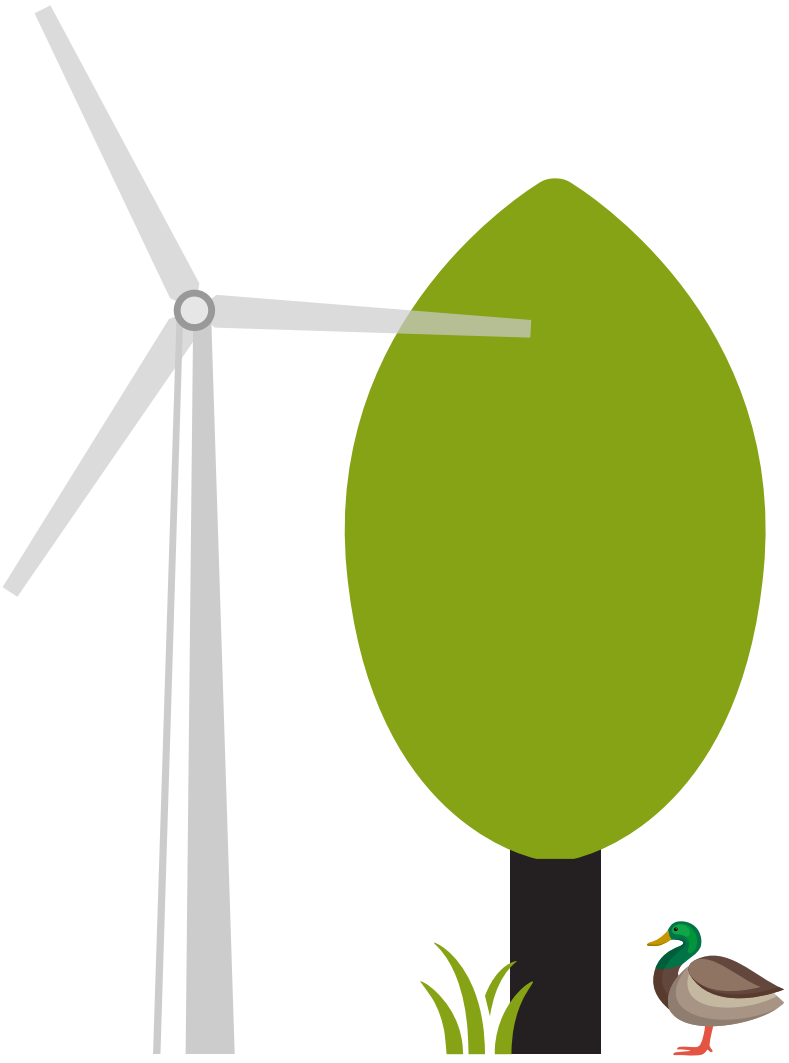
Over the last 12 months we've started to embed more complete measures across our Electricity Transmission business. This will help us measure and target financial and non-financial aspects of our environmental impact and operations.

We're still supporting the Prince's Accounting for Sustainability (A4S) project in areas like capital expenditure (capex), managing future uncertainty, and natural and social capital accounting. Our involvement includes working with and advising other businesses, especially on carbon management and human and social capital. We follow the project's basic principle: when making decisions about financial and social capital, it makes good business sense to consider sustainability.

Alongside this work we've continued to develop and trial a new approach to natural capital valuation. This approach considers how our decisions can affect the natural environment's ability to provide us with valuable services, such as flood control, visual screening and carbon storage. Our next step is to formally incorporate this approach into our decision-making framework – we hope to be able to do this in 2016.

We see sustainability as an effective driver for innovation and creativity, to deliver value for consumers. And we're starting to prove that doing something sustainably leads to improved efficiency and cost savings too.

We aim to reduce our greenhouse gas emissions by 45 per cent by 2020 and to implement Sustainable Action Plans at 50 of our sites by 2020.



Environmental Management System

Our Environmental Management System (EMS) provides the strong foundation our environmental sustainability strategy needs. It sets out the processes, procedures and measurement tools we use to manage our day-to-day environmental impact.

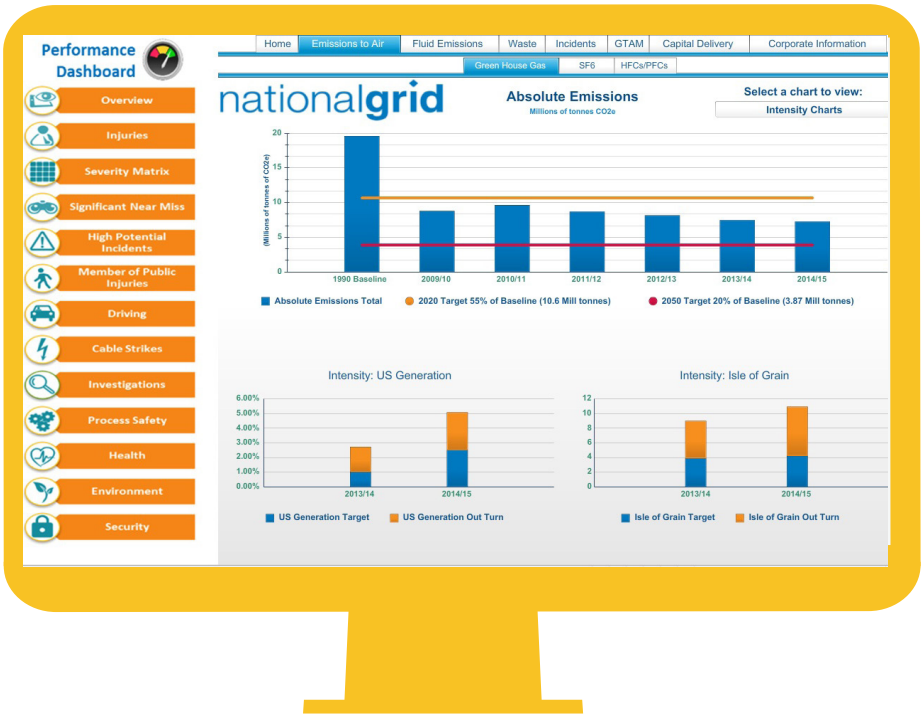
The EMS is independently verified and externally assessed every year, and any areas that we need to improve are highlighted. The 2015 ISO14001 audit was our best to date, with a significant improvement from 2014. The auditors visited nine Electricity Transmission sites, where they said our site operatives had a good understanding of environmental management. They also remarked on the value of the training course on Managing Environmental Risk that we introduced in January 2015.

A new ISO14001 standard was introduced in 2015. Instead of focusing on historical on-site environmental management, the new standard will look for evidence of pro-active climate change activities being embedded in the business. This puts us in a strong position because our EMS has increasingly focused on climate change activity, biodiversity and resource efficiency.

Incident categorisation

As part of our commitment to improving our EMS, we've changed the way we report environmental incidents. We've clarified and lowered some of the thresholds for reporting releases or spills. This raises the profile of these incidents by giving them a higher level of severity when they happen.

This change in the level of reporting is improving our environmental performance and inspiring us to challenge our accepted behaviours. It will help us meet our objectives and targets, particularly those relating to greenhouse gas (GHG) emissions.



Environmental dashboard

In February 2016 we launched a new version of our environmental dashboard, bringing together key environmental data from across the business. This will help us improve our environmental management performance.

The dashboard includes our latest data forecasting performance and trends. It shows a clear comparison between individual business unit performance and our overall corporate performance. Having easily accessible environmental data on fluid-filled cables and transformers and on SF_6, for example, will help identify potential hazards and ways to avoid environmental incidents.

Other benefits the dashboard brings to the business include:

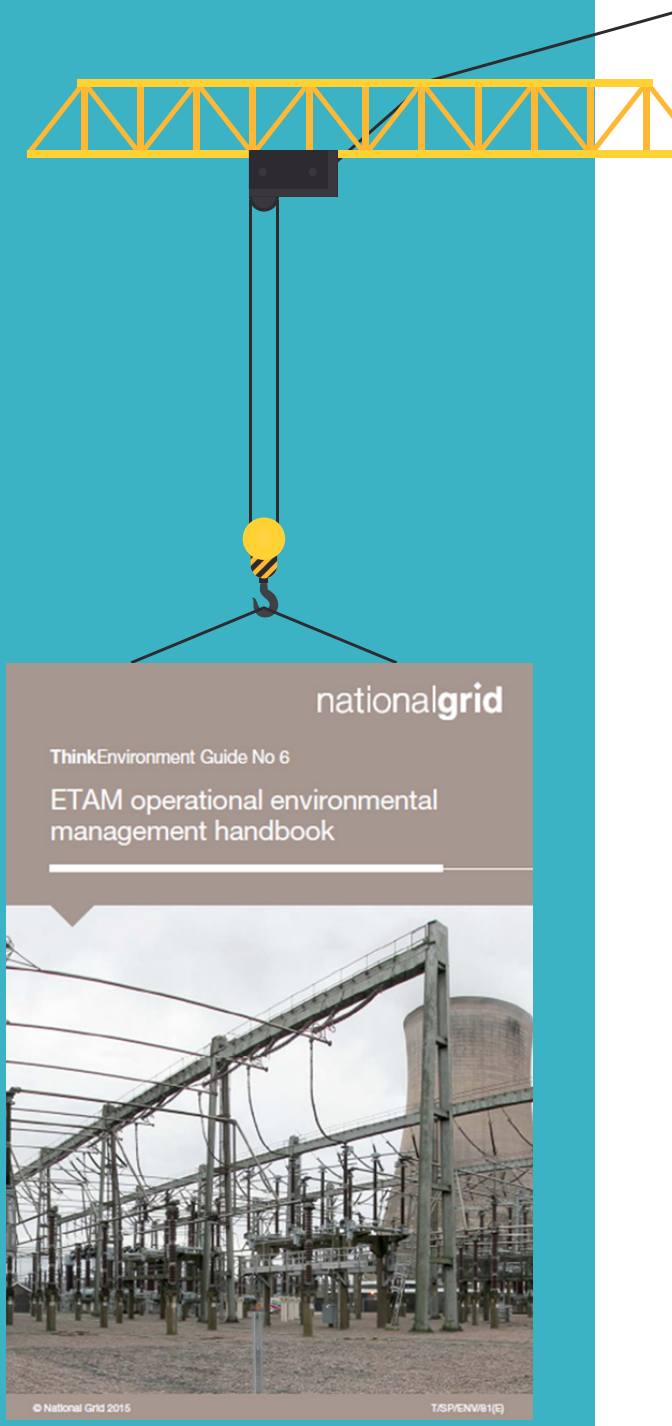
- easy-to-understand visual formatting
- developing data so that users can analyse and benchmark performance
- providing greater cost detail of environmental incidents.

The next phase of the dashboard will focus on addressing and building on internal stakeholder feedback, rather than adding more performance indicators. Stakeholder feedback has so far been very positive, with some areas of the business saying it helped them embed pro-active environmental management.

New handbook

We aim to make sure that all our employees and contractors understand how business activities impact on the environment and how to minimise this impact.

To help them, this year we combined three separate environmental operations guidance documents into a single, easy-to-understand handbook that we've distributed to all ETAM (electricity transmission asset management) sites. This concise document helps our operatives identify the risks and opportunities associated with managing our sites and assets.



This year we combined three separate environmental operations guidance documents into a single, easy-to-understand handbook that we've distributed to all ETAM sites.

Climate positive

We've set ourselves some challenging targets on GHG emissions to help us reduce environmental impact and combat climate change.

As we grow to meet the UK's energy demands, we continue to aim for a 45 per cent reduction in GHG emissions by 2020 and an 80 per cent reduction by 2050. We're pleased to report that we're making good progress towards these targets.

We have always reported our GHG emissions in an open and robust way. In November 2015 we were named as a FTSE 350 leader by the CDP (formerly known as the Carbon Disclosure Project) for the third year running. We scored 99 out of a possible 100, and were recognised for our transparent approach and detailed carbon emissions reporting. This helps us to benchmark our progress against other organisations and set goals for continual improvement.

We maintain a fierce focus on minimising SF_6 emission losses from electricity transmission operations. We are working to improve SF_6 management processes, which include training, inventory management, SF_6 handling and recording.

We also aim to reduce leakage by trialling an SF_6 capture technique and actively increasing planned repair and replacements of SF_6 switch gear. We're progressing with trials of an innovative low-carbon alternative to SF_6, which has a 98 per cent lower global warming potential. We relaunched our SF_6 Working Group in 2015 and use it as a focal point for progressing SF_6 issues.

Pathways to 2050

We're deciding how our long-term investment will help us meet our climate change targets. This year we've examined different ways to meet our 2050 target. The analysis looked at how we can reduce our emissions, and at market and energy scenarios that might have an indirect impact. We also looked at the cost benefits of different ways to reduce GHG emissions, so we can identify the most cost-effective way to reduce our carbon footprint.

Although our climate change targets relate specifically to emissions that we are directly responsible for, we're also working to reduce emissions from our supply chain that we influence indirectly. We're working with our suppliers, benchmarking and challenging them to encourage low-carbon innovation in their products and services.

Carbon pricing in decision-making

We're building on our involvement in the Infrastructure Carbon Review (ICR) and the A4S project by developing ways to make sure that sustainability is always part of our long-term investment decisions. We can incorporate carbon into our investment appraisal by 'putting a price' on carbon. We are trialling the impact of including lifetime carbon as part of the financial element of investment decisions. We also continue to focus on showing how reducing carbon can save money. Together, these initiatives will help us to make the right long-term decisions that benefit our customers and the environment.

Recognising and sharing best practice

We know we need to drive true innovation to move towards a low-carbon energy system, using the most up-to-date materials and specifications. So we've shared the CIT tool with our external providers and have run training to spread good practice and increase carbon knowledge.

We're continually improving the CIT, and have made it as user-friendly as

2015/16 statistics
(predictions from our half-year report)

We predict that we'll be responsible for
7.7m
tonnes of $CO_2(e)$*

... that's a
61%
reduction from our 1990 baseline

We estimate that our NGET business will emit
295,000
tonnes of $CO_2(e)$*

We continue to aim for a
80%
reduction in GHG emissions by 2050

* Excludes transmission losses

In November 2015 National Grid was awarded the Sustainability Leaders Award for Carbon Management.

possible. At the same time, we're embedding carbon management in all our decision-making processes.

Sustainability Leaders Award
In November 2015 National Grid was awarded the Sustainability Leaders Award for Carbon Management.

We're also helping to develop the Publicly Available Specification (PAS) for carbon management and we are working to gain PAS ourselves. It is used to increase efficiency, reduce costs and speed up innovation while meeting regulatory obligations and building trust with consumers.

Our involvement with PAS is helping us embed good practice in carbon management and establish standards in the energy sector.

During the Road to Paris – a campaign leading up to COP21 – we lobbied for greater ambition in the global climate change agreement. Our CEO Steve Holliday publicly expressed support for an ambitious climate change deal to be reached. We recognise that action must be taken to protect our environment and society, so we're working with We Mean Business, Business in the Community and CDP to support progressive global GHG emission reduction targets.

CASE STUDY

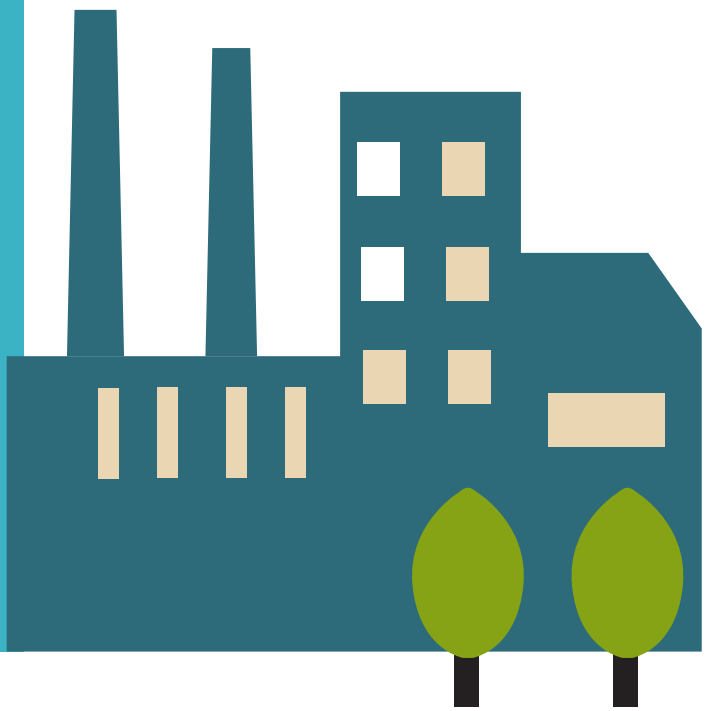
Lower cost, lower carbon

Our in-house carbon assessment Carbon Interface Tool (CIT) lets us estimate the projected carbon impact of our infrastructure projects. The tool has allowed us to develop our knowledge of GHG emissions associated with projects. With it, we can see which areas will have the greatest impact over an asset's lifetime and we can translate lower carbon into lower costs for electricity consumers.

Progress this year
We're trialling a five per cent weighting on carbon in major infrastructure projects. This approach gives our suppliers an incentive to reduce their carbon emissions and creates a benchmark and guidelines for best practice. It also helps us set carbon intensity targets for our construction schemes.

Changes to design and materials for a recent tender for an electricity substation in Wimbledon, London, resulted in significant cost savings and projected lifecycle carbon savings of more than 20 per cent against the original design. Changes included:

- reducing the volume of insulating gases, such as SF_6, in electricity transmission equipment
- using low-carbon concrete
- sourcing recycled steel for reinforcements.



Positive about resources

Rising global demand for resources is placing pressure on the availability of materials and resources that are essential for constructing and operating electricity transmission infrastructure.

We're committed to using plant and resources more effectively and we're making good progress towards our company-wide target of reusing or recycling 100 per cent of recovered assets by 2020.

The traditional construction model is based on buying new resources for new construction projects. But we want to take a different approach, based on using resources more efficiently and productively. This will mean we can maximise the value of the materials we own, mitigate risk from exposure to volatile costs and minimise the environmental, carbon and social impacts of resource production. We have been working closely with our supply chain to deliver these commitments.

Transition to a circular economy
To help in the transition to a low-carbon economy, we continue to support Circular Economy 100 as a member. We aim to use our resources more efficiently and have set up pilot projects with our suppliers to look at the benefits and costs of reusing redundant assets, which reduces the amount of new material needed.

We're also part of the Major Infrastructure Resource Optimisation Group. This peer consultation group aims to increase the resource efficiency of infrastructure developments by taking a collaborative approach to reducing the amount of materials used. We share best practice with other members and look for opportunities to integrate shared learning into our major electricity transmission projects.

We have continued to build on the success of our MARkit materials exchange tool this year. It allows us to make use of surplus transmission assets from construction projects that have been put on hold or cancelled. The tool has achieved supply-side savings of over £400,000 as well as significant resource savings.

A new approach to asset replacement
We're changing our approach to asset replacement. Our Act Now campaign aims to embed sustainability into our decision-making process, to reduce costs and save resources.

Rather than using our simple 'lifetime' approaches to asset replacement, we're moving to an approach based on condition and risk-assessment that's designed to replace only the infrastructure elements that need replacing. So it minimises our environmental impact because it means we don't completely replace large pieces of plant, such as a supergrid transformer, when we don't need to. It also reduces civil engineering costs and the amount of materials used.

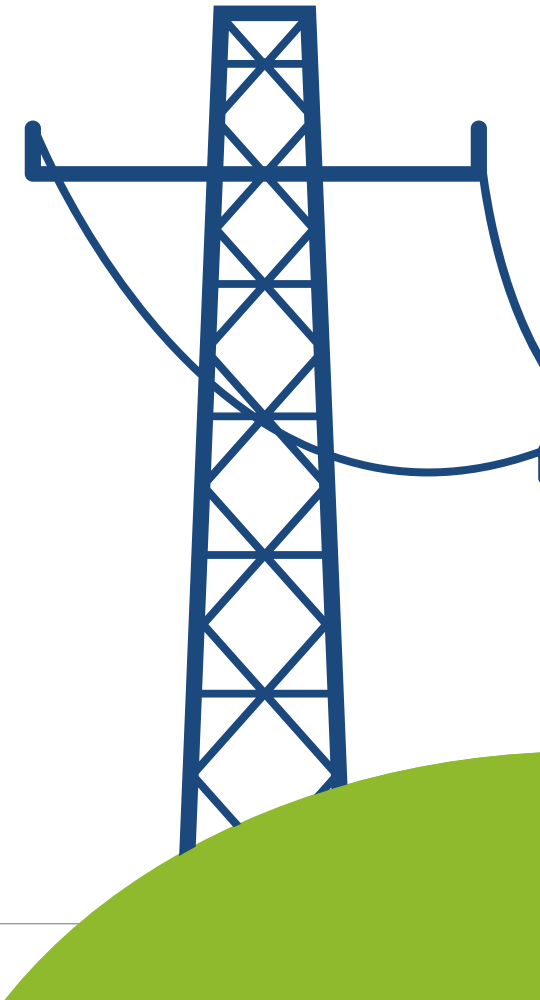
Sustainable procurement
Although our GHG emissions reduction targets focus on our direct emissions, we're also working with our supply chain to reduce our indirect emissions.

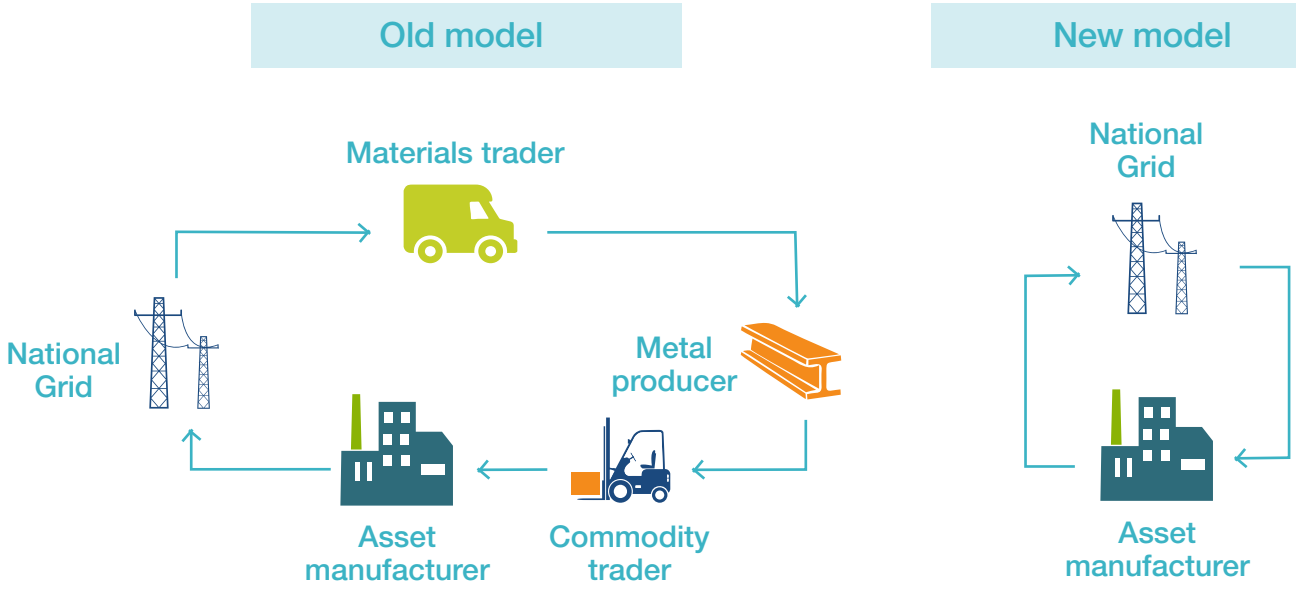
Since launching our Global Procurement Sustainability Policy in August 2015, we've been working closely with our supply chain to embed sustainable factors into the tendering process. Essentially, we're asking suppliers to 'do more with less'. This approach is helping to encourage suppliers to reduce demand, change to more environmentally friendly specifications and innovate to deliver low-carbon products.

This year we launched a pilot project to prioritise SF_6 reduction in the disposal and refurbishment of circuit breakers. We also plan to develop awareness of our goals by training our suppliers, to encourage them to feel confident in offering new solutions and innovations.

Recognising and sharing best practice
We're using lessons learned from our waste exportation challenges to influence future waste legislation at the EU level.

Working with the Aldersgate Group, we're supporting a lobby for stronger and more ambitious EU-level guidelines on the circular economy in Europe. The lobby encourages the sharing of best practice between organisations so that they can introduce similar models of upcycling their assets and reusing resources that they already have, rather than buying new – an idea in line with circular economy model.





CASE STUDY

Changing the model – overhead line upcycling

We're working towards changing the model for recycling metallic assets at the end of their operational life.

National Grid transmits electricity across the country using 7,200 km of overhead lines with aluminium conductor. Traditionally, when an aluminium conductor reaches the end of its operational life it's taken down and recycled. But in 2013 we piloted a new initiative: the conductors are transported to manufacturer Midal Cable's facilities in Bahrain for reprocessing and are then returned to National Grid.

It's an approach that uses fewer raw materials and protects against price volatility in the commodities market. Rather than recycling the materials down the value chain we're turning recovered materials into new conductors with a lifespan of 40 years.

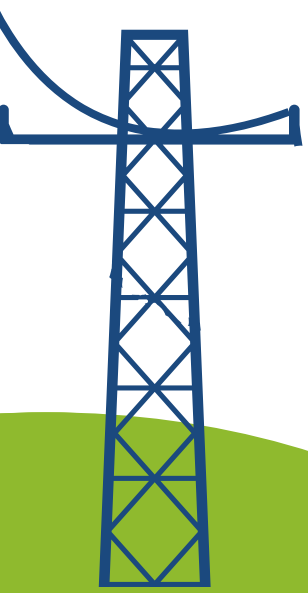
We've already sent 30 tonnes of aluminium conductors to Bahrain for reprocessing. However, upscaling this process and making it 'business as usual' has presented some challenges.

Progress this year

For example, under EU waste legislation, before the metal can be exported for reprocessing, it must have no grease on it from the original manufacture. To address this, in 2015 we launched a European metal recycling trial to develop cleaning processes for us to use in the large-scale roll-out of our upcycling project.

We now have two successful degreasing methods, so the material can be exported as green list – or 'low risk' - waste. We have processed a further 90 tonnes of aluminium cable, which is now ready for shipment to Midal, to be upcycled into new conductors.

We're now carrying out further trials to find the most cost-effective way to degrease and separate the steel and aluminium conductor components.



Enhancing ecosystems

Healthy and effective natural resources are essential to the sustainability and prosperity of our business and society.

The way we manage the natural environment has a direct impact on our business, our stakeholders and our communities.

For us to be able to operate in ways that minimise our impact and unlock new value for stakeholders, it's vital that we gain a better understanding of our relationship with the natural environment and the main benefits and values it provides to us.

That's why we're working to create new partnership models that will help us reduce the impact of our transmission assets, lower our carbon emissions and preserve the natural environment.

Our 'natural grid' approach

We're using our non-operational land and natural capital assets to create a natural grid of better, bigger and more connected spaces for biodiversity that unlock and add value to local communities.

Our approach centres on working with our partners and stakeholders to build a network of natural resource assets alongside our operational footprint. The network will result in benefits like biodiversity enhancement, habitat protection, carbon sequestration and management at a potentially lower cost, so will provide a positive return on investment for all those involved.

Progress on enhancing ecosystems

We aim to have 50 'enhancing ecosystems' sites in place by 2020. It's a sustainable model that we can apply across our sites to deliver business value. So far we're working with partners on 24 sites to manage our non-operational estates sustainably. We're creating new wildflower meadows, community woodlands, ponds and wetland features that are improving biodiversity in the local areas while also helping us to operate more efficiently.

Over the next 12 months we'll be kick-starting projects with new partners and landowners along our overhead line 'corridors'. These initiatives will help enhance the local ecosystem while also making sure that we maintain the resilience and reliability of our network.

Natural inventories

We're continuing to use our natural capital valuation tool to help build a natural capital inventory that will paint a comprehensive picture of the natural assets we own and are responsible for.

We plan to increase the value and resilience of our natural assets, to make sure they can deliver the ecosystem services that we and our wider beneficiaries need, in the most cost-effective way possible.

This approach supports the Natural Capital Committee's recommendation to the UK government, calling for organisations to create their own register of natural capital that they are responsible for – a responsibility that includes maintaining the quality and quantity of the assets listed.

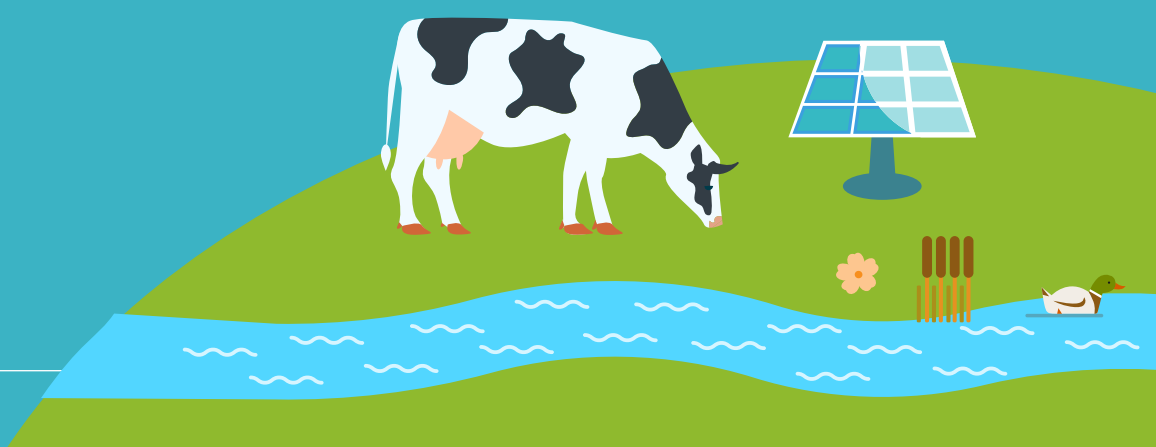
Carbon values

Woodlands, grasslands, wetlands and other habitats that we own deliver a wide range of valuable ecosystem services. A significant proportion of this value relates to natural carbon storage.

Incorporating these carbon values into our investment and management decisions helps us select better and more sustainable options that preserve valuable natural assets and deliver a positive return for our business and wider beneficiaries.

Recognising and sharing best practice

In November 2015 we were invited to share our natural capital approach at the World Forum for Natural Capital, held in Edinburgh. More than 600 delegates from 45 countries attended the event. We presented our approach as an example of how to integrate natural capital and the business value it can provide into decision making. We're looking for further opportunities to share best practice with other stakeholder groups in 2016.



CASE STUDY

Restoring our natural carbon stores

We're building a new substation at Rhigos, South Wales, for a new connection to the Vattenfall onshore windfarm. As part of this scheme we're working with local stakeholders to deliver a habitat management plan that will help restore the ancient peat bog – a natural carbon store – at Hirwaun.

The UK's peat bogs store around 3 billion tonnes of CO_2 in total. A healthy peat bog absorbs and stores carbon, whereas a dried-out bog releases carbon.

The condition of the peat bog at Rhigos had deteriorated over time through historical peat extraction and drainage.

To restore the bog, water levels in existing ditches needed to be raised by installing small dams.

The dams were installed in December 2015 by specialist consultant Rigare Ltd, working with National Grid and the Habitat Management Forum. The water levels have since risen by 0.8 metres – ideal for encouraging peat-forming bog vegetation, which in turn will help keep the water level close to the surface and make sure the carbon can be stored effectively.

By working with Natural Resources Wales, Rhondda Cynon Taf County Borough Council, Butterfly Conservation and other local stakeholders, we've altered the land boundary of the substation in order to preserve this historic and valuable peat bog.

Actively managing our most valuable natural assets through expert partnerships and guided by local stakeholders is an essential part of our natural grid strategic approach.

We used our natural capital valuation tool to demonstrate how restoring the habitat at Rhigos has brought a range of benefits to the local ecosystem. Examples include improved flood control and water quality and a greater diversity of wild species.

In 2016 we'll be monitoring the effectiveness of our actions at Rhigos and continuing to deliver habitat improvements across our sites.

Leading innovation

Our innovation strategy focuses on making a difference for consumers and stakeholders.

As the transmission network owner for England and Wales, our innovation focuses on four value areas for consumers:

- **managing assets**
optimising asset lives by using improved asset knowledge and analytics and finding ways to use new materials and automation

- **efficient build**
delivering new assets faster and cheaper

- **service delivery**
developing stakeholder-focused and customer-focused capabilities through exploiting existing assets and developing new service-based business propositions

- **corporate responsibility**
doing the right thing for our communities and the environment, and leading the development of sustainable and safe ways to keep energy flowing.

And as the system operator for Great Britain (GBSO), we're addressing the future challenges of operating the system securely, reliably and efficiently, facilitating low-carbon generation and delivering affordability:

- **demand**
finding innovative ways to balance electricity generation with demand, through activities on the distribution side of the network

- **operating with non-synchronous generation**
learning to run the network with higher levels of renewable generation such as wind and solar

- **distributed generation**
learning to deal with local generation connected to the distribution networks, and improving our forecasting to accommodate the changing nature of demand

- **smart grids**
identifying and demonstrating smart solutions, such as communications technology to improve transmission capacity and keep the costs to customers down

- **risk management**
as our system operator role evolves we are learning how to manage new risks.

Efficiency and sustainability are integral to all our innovation projects, to reduce our own carbon footprint and the carbon footprints of others who use our network.

Updates on previously reported projects:

Capturing debris during tower maintenance

- reducing our reliance on finite resources
- reducing our carbon footprint
- minimising environmental pollution.

Regular cleaning and repainting reduce the need to replace the towers that support our extensive network of overhead lines. Working with three project partners, we're developing different ways of capturing and disposing of the debris caused by maintenance work on these towers. Following successful trials we're now evaluating options for using hand-held or trailer-mounted vacuum systems and, in particularly sensitive areas, encasing the towers in netting.

Forecasting renewable energy production

- predicting the output from renewables
- reducing the need for standby generation
- supporting the transition to a low carbon energy system.

We're working with Reading University using advanced weather modelling techniques to explore how wind travels between the turbines in offshore wind farms and the effect this has on power generation. Our aim is to identify weather patterns that could make wind power forecasting difficult, to reduce costs to the system operator and energy consumers.

There's more detail on this in our **short film**.

We're working with Reading University using advanced weather modelling techniques to explore how wind travels between the turbines in offshore wind farms

Trials at three substations proved that we can harvest heat from substation transformers to provide heat and hot water to nearby buildings

Through ground-breaking research we're pushing ahead with new approaches to carbon reduction

Reactive power exchange application capability transfer (REACT)
We led on a project with all six distribution network operators and the University of Manchester to understand the complex interaction between active and reactive power demand and to establish why there's a reduction in reactive power across the country. Collaboration between industry parties on this scale is rarely seen, but it's vital to the future development of the UK's low-carbon energy market.

Our detailed findings will inform decarbonisation strategies across the sector and prepare us to comply with the new European Demand Connection Code, to accelerate decarbonisation.

Transformer heat recovery
Heat is given off to the environment during the normal operation of substation transformers. Successful trials at three substations have proved that this heat can be harvested in sufficient quantities to provide nearby buildings with heat and hot water. In one case, the system has been extended to supply heat to a local community education centre, reducing its energy costs.

Working in close collaboration with Rook Services, we have retro-fitted heat recovery systems to super-grid transformers and installed fan-assisted radiators in associated buildings. These are capable of using 60 per cent less energy than conventional versions. Estimates show a total annual reduction to date of nearly 70 per cent in the use of LV electricity across the test sites.

This project was a finalist in the Built Environment category of the Institute of Engineering and Technology (IET) Innovation Awards 2015.

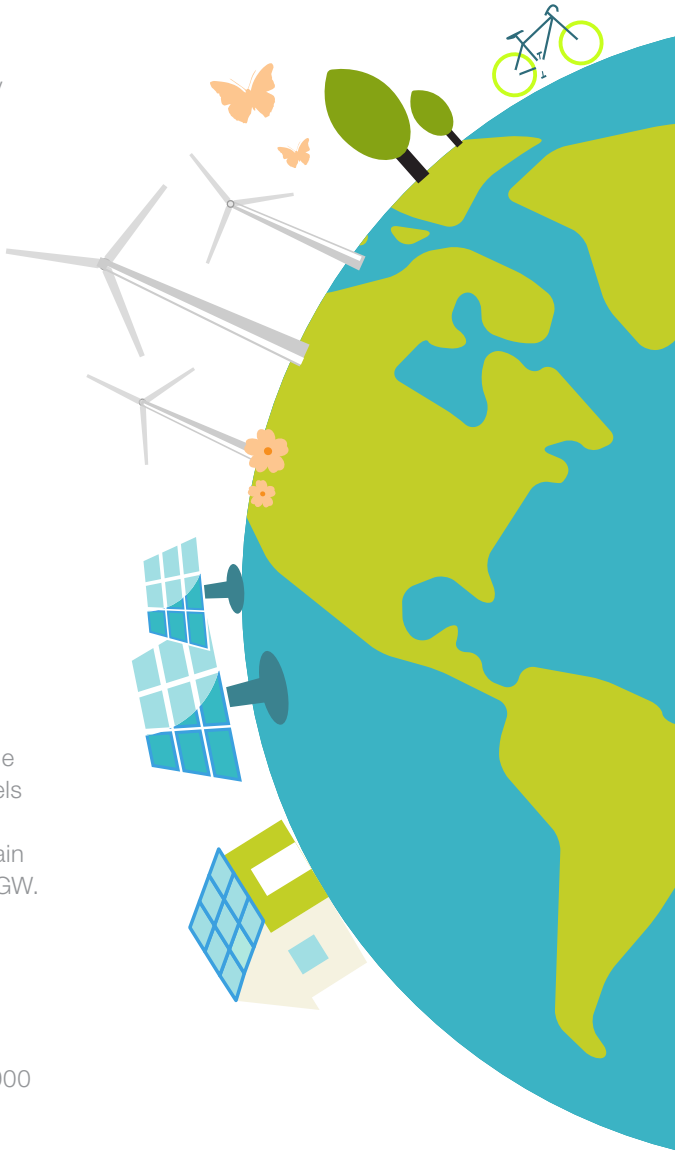
What next?

Solar PV
What we've learnt from our wind power projects is informing new work with solar. We're measuring the output of sample solar PV installations to estimate the total GB-wide solar PV output. From this we'll develop a system that can provide real-time estimates of solar power production, making sure that generation matches demand.

This is timely because there has been a rapid increase in the rate of installation of solar panels in recent years, taking the installed capacity in Great Britain from almost nil to more than 9GW. This is in addition to 13GW of installed wind power.

Finding alternatives to SF_6
The insulating gas SF_6 has a greenhouse effect around 23,900 times more potent than CO_2. Our previous focus has been on projects designed to manage our use of SF_6 and reduce system leaks.

We're now beginning an exciting collaboration with Alstom to replace SF_6 with G3 (Green Gas for Grid). G3 is a new gas mixture that matches the dielectric strength of SF_6 and reduces the global warming potential from 23,900 to 345. Look out for news of the trial, which is taking place at a substation in Kent – it's the first in the world to install this new gas on live equipment.



Leading the way to a low-carbon energy system

Let us know what you think…

We'll keep sharing information with you about the projects outlined in this document. We'll do this at events like our customer seminars and operation forums.

In the meantime, we'd really like to receive your answers to the three questions below.

We welcome all feedback because it helps us make sure we're focusing on the right areas and delivering the right things.

Please let us know the following:

- what do you think our key area of focus should be, to ease the transition to a low-carbon future, and why?
- what do you think our key area of focus should be, to better manage our impact on the environment, and why?
- is there anything else you would like to comment on or share with us?

Please email your responses to talkingnetworkstransmission@nationalgrid.com – you can also use this email address for queries and to ask for more information.

And here's the link to our survey: https://www.surveymonkey.co.uk/r/DEOF2016